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HEWLETT PACKARD

3478A Multimeter

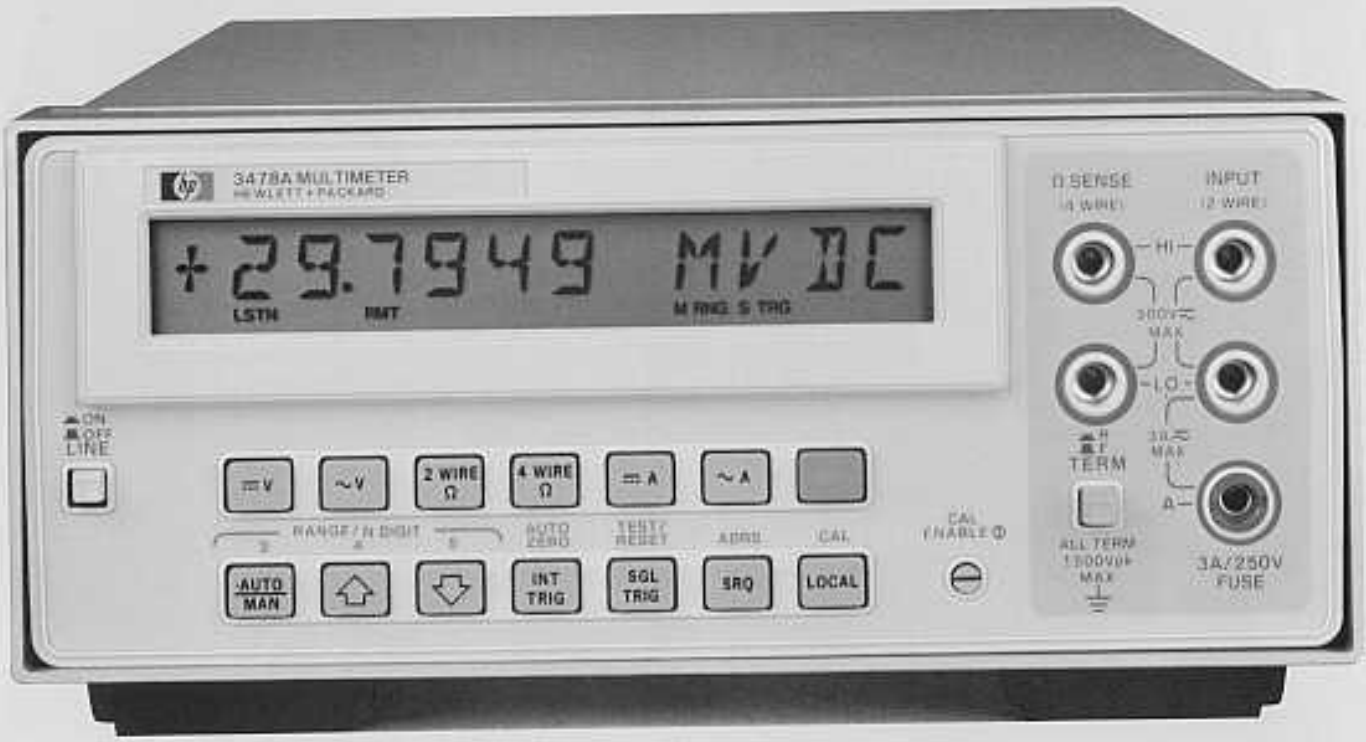
DESIGNED FOR HP-IB SYSTEMS

Technical Data November 1981



complete HP-IB programmability at a low cost

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Low Cost Automation

Now, you can have a completely programmable HP-IB* dmm for your system at a low cost. The HP 3478A is an autoranging, 3½ to 5½ digit, five function dmm with 100 nanovolt sensitivity to solve your most precise applications. With its complete capability to measure dc volts, true RMS ac volts, 2- and 4-wire ohms, and current, the 3478A can provide you with a flexible set of measurements for your system.

All of the performance of the 3478A can be controlled with one of HP's wide range of HP-IB compatible computers. By combining a powerful computer with the 3478A, you can automatically store your test data, analyze the data, and present the data in a suitable format for your application.

The 3478A can be completely calibrated electronically without any adjustments, providing you with an easy and simple calibration procedure for a lower cost of ownership.

Many conveniences, such as front/rear inputs, HP-IB enhancements, synchronizing signals, and a rack mountable package are built into the 3478A to give you more performance and ease of use in your system.

* HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.



Easily develop programs for HP-IB systems.



Production automation with HP computers.

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High Performance For Your System

The 3478A lets you measure dc volts, true RMS ac volts, 2- and 4-wire ohms, and current with 3½, 4½ or 5½ digit resolution. You can measure dc voltage from 30 mV full scale range with 100 nanovolt sensitivity up to 300 volts. This wide dynamic range enables you to detect low level signals or higher voltages and reduces the amount of signal conditioning necessary. The 3478A has a 300 kHz bandwidth and 4:1 crest factor to give you confidence in your true RMS ac voltage measurements. Either 2-wire or 4-wire ohms measurements can be selected with a maximum range of 30 megaohms down to a 100 microohm sensitivity on the 30 Ω range. You can use 4-wire ohms for reducing errors caused by cable resistance and relay scanners in your system or use 2-wire ohms for convenience. Both .3A and 3A ranges of dc and true RMS ac current are provided, completing the function capability of the 3478A.

Fast autoranging is incorporated into the 3478A to improve your system throughput by getting your measurements faster.

The 3478A uses an integrating analog to digital conversion technique to give you ample noise rejection. In a system, the ability to reject noise provides you with more repeatable measurements. You can select a display of 3½, 4½ or 5½ digits for faster measurement speed or for additional noise rejection. For example, with a display of 3½ digits selected, the 3478A can take a maximum of 71 readings/second. When you increase the resolution to 5½ digits, reading speed is reduced to 4.4 readings/second and noise rejection is greatly increased.

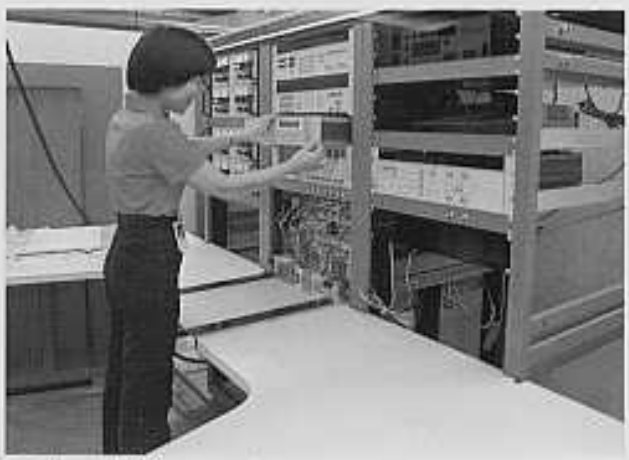
Get Started Quickly With HP-IB

With HP-IB you get complete programmability of functions, ranges, and other modifiers, so you can incorporate the 3478A into a fully automatic system. The 3478A's HP-IB interface is electrically, mechanically and functionally compatible with IEEE-488, a worldwide standard for interfacing instruments. But HP-IB means much more than just IEEE-488 compatibility. The 3478A with HP-IB should help you build and use your system in a minimum amount of time. It has been designed with systems capability from the beginning, not just added on. You also get documentation, service, and support that assist you from system planning to operation and maintenance of your system.

Besides simply providing data to the computer, the 3478A has an SRQ interrupt capability that lets you know precisely when the data is ready. This feature and other SRQ interrupt capabilities built into the 3478A allow you more efficient use of your computer time.



Printhead characterization in Production Engineering.



Building an HP-IB automatic test system.

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Minimize Your Cost of Ownership

The 3478A dmm has been designed to reduce your cost of ownership by providing higher reliability and easier calibration. Reliability has significantly improved through a design and manufacturing philosophy with uncompromising reliability and quality goals.

Fast Electronic Calibration

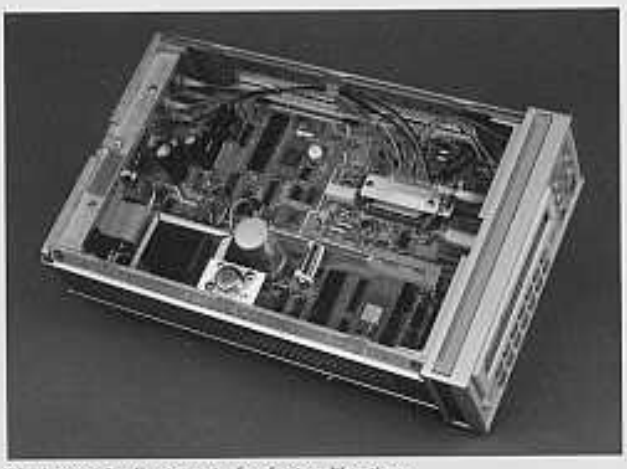


Complete calibration of the 3478A is done electronically, either manually from the front panel or remotely in an automatic calibration system. There are no internal adjustments. Complete calibration of all functions is done without removal of the instrument's covers, thus saving valuable time and reducing cost. The calibration procedure for the 3478A involves connecting a calibration standard to the input, then pressing three keystrokes to store one calibration constant in CMOS RAM for each range and function. When the 3478A makes a measurement, each reading is corrected according to the calibration constants that have been stored. The internal CMOS RAM used in the 3478A is powered by a lithium battery to create a nonvolatile memory capable of holding the calibration constants for more than ten years.

Self-Test



The built-in self-test feature in the 3478A assures you that the instrument is functioning properly. A comprehensive check of both analog and digital circuits is performed while activating all display segments. A message is then displayed, indicating proper operation of the 3478A.



No internal adjustments for fast calibration.

Enhanced HP-IB



With an extensive set of service request capability including data ready, front panel SRQ, and power-on SRQ, the 3478A offers you more flexibility in your system. You can program the data ready service request of the 3478A to interrupt your computer after a measurement is taken, so you efficiently use computer time. The front panel SRQ lets an operator of your system interrupt the computer from the 3478A front panel. You can also have the 3478A interrupt at power-on so you can detect when power has been lost.

The 3478A dmm uses an easy-to-read, liquid crystal display that provides measurement units as part of the reading for unambiguous answers. The annunciators below the reading show instrument status and status of the HP-IB interface. With the HP-IB interface you can display words or messages for prompting or displaying answers in user units such as degrees or RPM.

Switchable Inputs



Both front and rear terminals are provided on the 3478A for convenient troubleshooting at your test position and for your system's inputs. The position of the front/rear terminal switch of the 3478A's front panel can be sensed via HP-IB, so you can effectively use both sets of terminals in your system.

Synchronization

A Voltmeter Complete output on the rear panel of the 3478A provides you with a signal that occurs after a measurement is completed. This output signal lets you conveniently advance an HP scanner to the next channel so you can enhance scanning speed. The External Trigger input lets you initiate a measurement in the 3478A and synchronize with an external device.



Switchable rear inputs and synchronizing signals.

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Specifications

DC VOLTAGE

Input Characteristics:

Range	Maximum Reading (5½ digit)	Resolution		
		5½ digit	4½ digit	3½ digit
30 mV	±30.3099 mV	100 nV	1 µV	10 µV
300 mV	±303.099 mV	1 µV	10 µV	100 µV
3 V	±3.03099 V	10 µV	100 µV	1 mV
30 V	±30.3099 V	100 µV	1 mV	10 mV
300 V	±303.099 V	1 mV	10 mV	100 mV

Input Resistance:

30 mV, 300 mV, 3 V ranges: $>10^{10}\Omega$
30 V, 300 V ranges: 10 MΩ ± 1%

Maximum Input Voltage: (non-destructive)

Hi to Lo: 303 Vrms or 450 V peak
Hi or Lo to Earth Ground: ±500 V peak

Measurement Accuracy:

±(% of reading + number of counts)
Auto zero ON.

5½ DIGIT MODE:

Range	T_{Cal}* ±1°C	T_{Cal}* ±5°C	
	24 Hour	90 Day	1 Year
30 mV	0.027 + 35	0.03 + 41	0.04 + 41
300 mV	0.005 + 4	0.007 + 5	0.02 + 5
3 V	0.0034 + 2	0.006 + 2	0.019 + 2
30 V	0.005 + 3	0.007 + 3	0.02 + 3
300 V	0.0055 + 2	0.008 + 2	0.02 + 2

4½ AND 3½ DIGIT MODE:
Accuracy is the same as 5½ digit mode for % of reading; use 1 count for number of counts on all ranges except 30 mV range, use 4 counts.

Auto Zero Off:

(5½ digits) For a stable environment (±1°C) for <24 hrs., add 110 counts to accuracy specification for 30 mV range, 11 counts for 300 mV and 30 V ranges, 3 counts for 3 V and 300 V range.

Temperature Coefficient:

0° to 55°C, 5½ digits, auto zero ON.
±(% of reading + number of counts)/°C

Range	Temperature Coefficient
30 mV	0.0028 + 0.5
300 mV	0.0005 + 0.5
3 V	0.0004 + 0.05
30 V	0.0006 + 0.5
300 V	0.0004 + 0.05

Noise Rejection:

In dB with 1 kΩ imbalance in Lo lead. AC rejection for 50, 60 Hz ±0.1%. Auto zero ON.

Display	AC NMR	AC ECMR	DC CMR
5½ digits	80	140	140
4½ digits	59	120	140
3½ digits	0	60	140

Maximum Reading Rates: (readings/sec)

Line Frequency	Auto Zero	Resolution		
		3½ digits	4½ digits	5½ digits
60 Hz	Off	71	33	4.4
	On	53	20	2.3
50 Hz	Off	67	30	3.7
	On	50	17	1.9

The reading rates are dependent on the speed of the controller being used.

First reading is correct when triggered coincident with step input.

*T_{Cal} is the temperature of the environment where the 3478A was calibrated. Calibration should be performed with the temperature of the environment between 20°C and 30°C.



Production testing of temperature probes.



Stress testing new ICs under development.

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RESISTANCE (2-wire Ω, 4-wire Ω)

Input Characteristics:

Range	Maximum Reading (5½ digit)	Resolution		
		5½ digit	4½ digit	3½ digit
30 Ω	30.3099 Ω	100 µΩ	1 mΩ	10 mΩ
300 Ω	303.099 Ω	1 mΩ	10 mΩ	100 mΩ
3 kΩ	3.03099 kΩ	10 mΩ	100 mΩ	1 Ω
30 kΩ	30.3099 kΩ	100 mΩ	1 Ω	10 Ω
300 kΩ	303.099 kΩ	1 Ω	10 Ω	100 Ω
3 MΩ	3.03099 MΩ	10 Ω	100 Ω	1 kΩ
30 MΩ	30.3099 MΩ	100 Ω	1 kΩ	10 kΩ

Input Protection: (non-destructive)
Hi source to Lo source: ±350 V peak
Hi sense to Lo sense: ±350 V peak
Hi or Lo to Earth Ground: ±500 V peak

Measurement Accuracy:
±(% of reading + number of counts)
Auto zero ON. 5½ digit display. 4-wire ohms.

Range	T_{Cal} ±1°C	T_{Cal} ±5°C	
	24 Hour	90 Day	1 Year
30 Ω	0.023 + 35	0.027 + 41	0.034 + 41
300 Ω	0.0045 + 4	0.012 + 5	0.017 + 5
3 k–300 kΩ	0.0035 + 2	0.011 + 2	0.016 + 2
3 MΩ	0.0052 + 2	0.011 + 2	0.016 + 2
30 MΩ	0.036 + 2	0.066 + 2	0.078 + 2

2-WIRE OHMS ACCURACY:
Same as 4-wire ohms except add a maximum of 200 mΩ offset

Auto Zero Off:
(5½ digits) For a stable environment (±1°C) for <24 hrs., add 110 counts to accuracy specification for 30 Ω range, 11 counts for 300 Ω range, 3 counts for 3 kΩ through 300 kΩ ranges, 8 counts for 3 MΩ range, and 33 counts for 30 MΩ range.

Temperature Coefficient:
0° to 55°C, 5½ digits, auto zero ON.
±(% of reading + number of counts)/°C

Range	Temperature Coefficient
30 Ω	0.003 + 5
300 Ω	0.009 + .5
3 k–300 kΩ	0.0009 + .05
3 MΩ	0.0021 + .05
30 MΩ	0.021 + .05

Current Through Unknown:

Range	Current
30 Ω	1 mA
300 Ω	1 mA
3 kΩ	1 mA
30 kΩ	100 µA
300 kΩ	10 µA
3 MΩ	1 µA
30 MΩ	100 nA

Maximum Open Circuit Voltage: 6.5 V

Maximum Reading Rates:
Same as dc volts except for 3 MΩ and 30 MΩ ranges. For 3 MΩ range, add 30 ms; for 30 MΩ range, add 300 ms per reading.

DC CURRENT

Input Characteristics:

Range	Maximum Reading (5½ digit)	Resolution		
		5½ digit	4½ digit	3½ digit
300 mA	±303.099 mA	1 µA	10 µA	100 µA
3 A	±3.03099 A	10 µA	100 µA	1 mA

Maximum Input: (non-destructive)
3A from <250 V source; fuse protected

Measurement Accuracy:
±(% of reading + number of counts)
Auto zero ON. 5½ digit display.

Range	T_{Cal} ±5°C	
	90 Days	1 Year
300 mA	0.11 + 40	0.15 + 40
3 A, <1 A input	0.14 + 6	0.17 + 6
3 A, >1 A input	1.0 + 3	1.0 + 30

Auto Zero Off:
(5½ digits) For a stable environment (±1°C) for <24 hrs., add 110 counts to accuracy specification for 300 mA range; add 11 counts for 3 A range.

Temperature Coefficient:
0° to 55°C, 5½ digits, auto zero ON.
±(% of reading + number of counts)/°C

Range	Temperature Coefficient
300 mA	0.012 + 5
3 A	0.012 + 0.5

Maximum Burden at Full Scale:
1 V

Maximum Reading Rates:
Same as dc volts

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AC VOLTAGE (true rms responding)

Input Characteristics:

Range	Maximum Reading (5½ Digit)	Resolution		
		5½ Digit	4½ Digit	3½ Digit
300 mV	303.099 mV	1 µV	10 µV	100 µV
3 V	3.03099 V	10 µV	100 µV	1 mV
30 V	30.3099 V	100 µV	1 mV	10 mV
300 V	303.099 V	1 mV	10 mV	100 mV

Input Impedance:
1 MΩ ± 1% shunted by <60 pF

Maximum Input Voltage: (non-destructive)
Hi to Low: 303 Vrms or 450 V peak
Hi or Lo to Earth Ground: ±500 V peak

Measurement Accuracy:
±(% of reading + number of counts)
Auto zero ON. 5½ digit display. Accuracy is specified for sinewave inputs only, >10% of full scale.

1 YEAR, T_{Cal} ±5°C

Frequency	Ranges		
	300 mV	3 V, 30 V	300 V
20–50 Hz	1.14 + 163	1.14 + 102	1.18 + 102
50–100 Hz	0.46 + 163	0.46 + 103	0.5 + 102
100 Hz–20 kHz	0.29 + 163	0.26 + 102	0.33 + 102
20–50 kHz	0.56 + 247	0.41 + 180	0.55 + 180
50–100 kHz	1.74 + 882	1.05 + 825	1.26 + 825
100 k–300 kHz	10.1 + 3720 (30 V range only)		

Auto Zero Off:
(5½ digits) For a stable environment (± 1°C) for <24 hrs., add 10 counts to accuracy specification for all ranges.

Temperature Coefficient:
0° to 55°C, 5½ digits, auto zero ON.
For frequencies <20 kHz, ±(0.016% of reading + 10 counts)/°C
For frequencies >20 kHz, ±(0.04% of reading + 10 counts)/°C

Crest Factor:
>4:1 at full scale

Common Mode Rejection:
With 1 kΩ imbalance in Lo lead, >70 dB, dc to 60 Hz

Maximum Reading Rates:
Reading rates are the same as dc volts using fast trigger (T5). Using Normal Trigger (T1, T2, T3):
For 50 or 60 Hz operation, auto zero ON or OFF.
3½ or 4½ digits: 1.4 readings/sec
5½ digits: 1.0 readings/sec

First reading is correct within 70 counts of final value when triggered coincident with step input. Add 0.6 seconds for each range change.

AC CURRENT (true rms responding)

Input Characteristics:

Range	Maximum Reading (5½ digit)	Resolution		
		5½ digit	4½ digit	3½ digit
300 mA	303.099 mA	1 µA	10 µA	100 µA
3 A	3.03099 A	10 µA	100 µA	1 mA

Maximum Input: (non-destructive)
3A from <250 V source; fuse protected

Measurement Accuracy:
±(% of reading + number of counts)
Auto zero ON. 5½ digit display. Accuracy is specified for sinewave inputs only, >10% of full scale.

1 YEAR, T_{Cal} ±5°C

Frequency	Ranges	
	300 mA	3 A
20–50 Hz	1.77 + 163	2.5 + 163
50–1 kHz	1.1 + 163	1.8 + 163
1 k–10 kHz	1.0 + 163	1.7 + 163
10 k–20 kHz	1.14 + 163	1.84 + 163

Auto Zero Off:
(5½ digits) For a stable environment (± 1°C) for <24 hrs., add 10 counts to accuracy specification.

Temperature Coefficient:
0° to 55°C, 5½ digits, auto zero ON.
±(0.021% of reading + 10 counts)/°C

Maximum Burden at Full Scale:
1 V

Crest Factor:
>4:1 at full scale

Maximum Reading Rates:
Same as ac volts

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General Information

Operating Temperature: 0 to 55°C

Humidity Range: 95% R.H., 0 to 40°C

Storage Temperature: −40°C to 75°C

Warm-up Time: 1 hr. to meet all specifications

Power:
AC Line 48−440 Hz; 86−250 V, (see configuration)

Maximum Power: 25 VA

Integration Time:

Number of Digits	Line Frequency	
	50 Hz	60 Hz
5½	200 ms	166.7 ms
4½	20 ms	16.67 ms
3½	2 ms	1.667 ms

Size: 102 mm H x 215 mm W x 356 mm D
(4 in H x 8 in W x 14 in D)

Weight: 3 kg (6.5 lbs.)

ACCESSORIES

	Price
34118A Test Lead Kit	$ 25
11096B RF Probe, detects AC Voltage up to 700 MHz	$ 120
34111A High Voltage Probe, 1000 to 1 dc High Voltage Divider for up to 40 kVdc	$ 150
10023A Temperature Probe	$ 150
10631A: 1 meter HP-IB Cable	$ 60
10631B: 2 meter HP-IB Cable	$ 80
10631C: 4 meter HP-IB Cable	$ 90
10631D: 0.5 meter HP-IB Cable	$ 75

ORDERING INFORMATION

Configuration: Order one power and frequency option at no charge from below:
Option 315; 100 volts, 50 Hz
Option 316; 100 volts, 60 Hz
Option 325; 120 volts, 50 Hz
Option 326; 120 volts, 60 Hz
Option 335; 220 volts, 50 Hz
Option 336; 220 volts, 60 Hz
Option 345; 240 volts, 50 Hz
Option 346; 240 volts, 60 Hz

	Price
3478A dmm with HP-IB Interface	$1300
Option 907, Front Handle Kit, (P/N 5061-0088)	$ 46
Option 908, Rack Mount Kit including one rack flange and one extension adapter (P/N 5061-0072)	$ 34
Option 910, Extra Operating and Service Manuals	$ 14

DOMESTIC U.S.A. PRICES ONLY

More HP-IB Performance



3456A Digital Voltmeter
- 3½ to 6½ digits
- high performance



3437A System Voltmeter
- 3½ digits
- high speed
- programmable delay

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